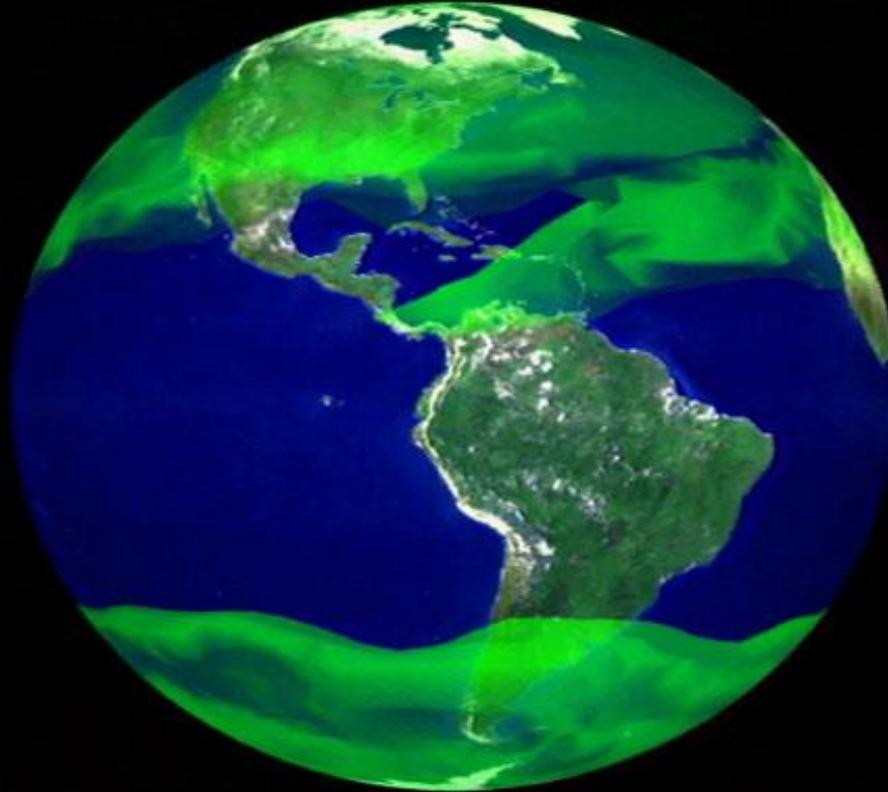


Anaerobic Digestion



*Chad Kruger,
WSU Center for Sustaining
Agriculture & Natural Resources*

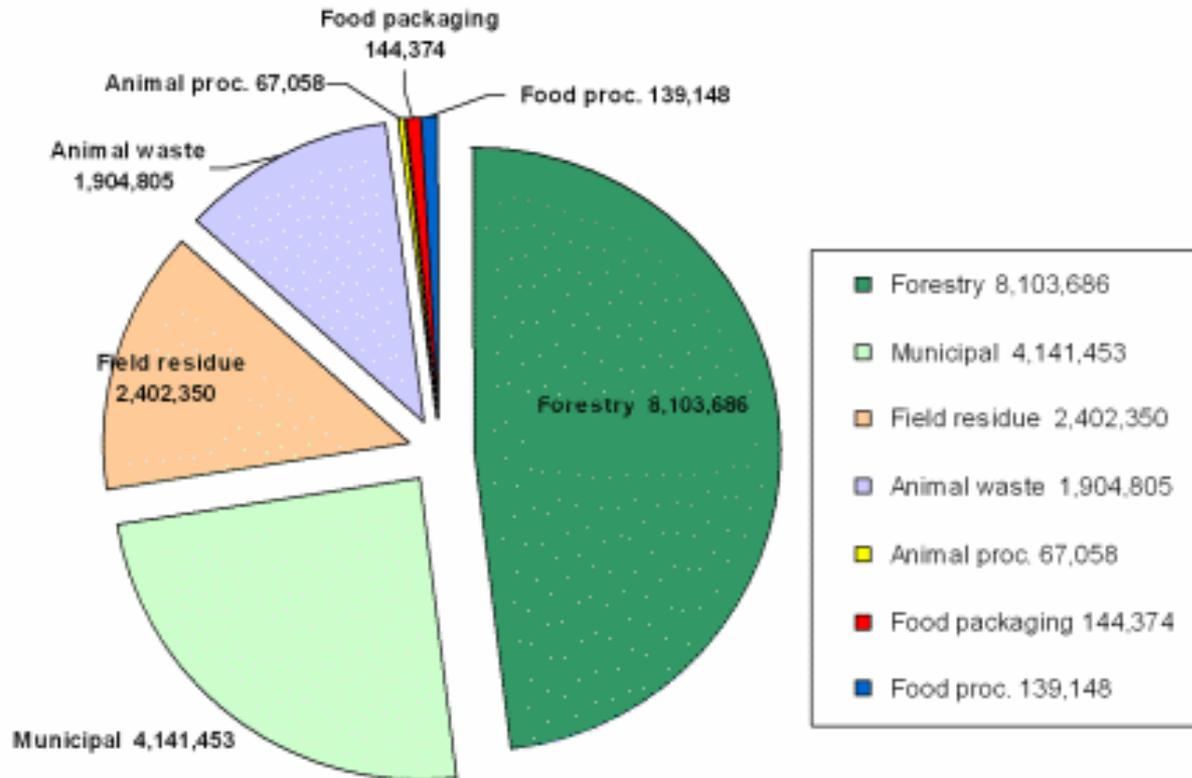
December 2008

WASHINGTON STATE
 **UNIVERSITY**
World Class. Face to Face.

Washington's bioenergy feedstocks

Washington Biomass Inventory

(16,900,000 dry tons)



Current Anaerobic Digestion Technology

Current AD performance

VFA reduction	99%
VS reduction	40 – 45%
FC reduction	99%



- WA dairies larger than 500 cows ~ .5 MMTCO₂ E annually in methane destruction / recovery;
- ~1.9 MMTCO₂ E for food waste

See ASCMW Report, section V

http://www.ecy.wa.gov/climatechange/2008FAdocs/Ag_Offset_Recc_Pkg_FINAL.pdf

Current AD Technology

	NPV	IRR
• Vander Haak System <u>as is</u> – (~700 cows + food waste)	\$1.3M	18.7%
• No grants	0.9M	10.2%
• 1,300 cows and no food waste	1.7M	23.4%
• Increase electricity price to \$0.06 / kWh (~2x)	1.7M	21.6%
• No food waste tipping fees	-2.0M	
• European carbon credit market (~4x)	2.5M	28.9%
• All digested fiber sold for \$20 per ton (~2x)	2.5M	25.3%

Shumway and Bishop, forthcoming

Extra receipts from co-digestion can represent as much as **64%** of the total project revenue

AD in the near future (1 – 3 years)



Anaerobic Digesters as a fertilizer plant!

Nutrient	% change after AD
Ammonia N	+23%
Total N	+57%
Total P	+13%
Total K	-7%

From largest 135 WA Dairies (167k cows, 50k heifers):
- N recovered ~ 20% of state's on-farm demand for N
- P recovered ~27% of state's on-farm demand for P

AD in the near future (1 – 3 years)



Digested Dairy Solids as a commercial potting substrate – WSU / MacConnell, Patent Pending

Value = \$25 – \$250 / ton

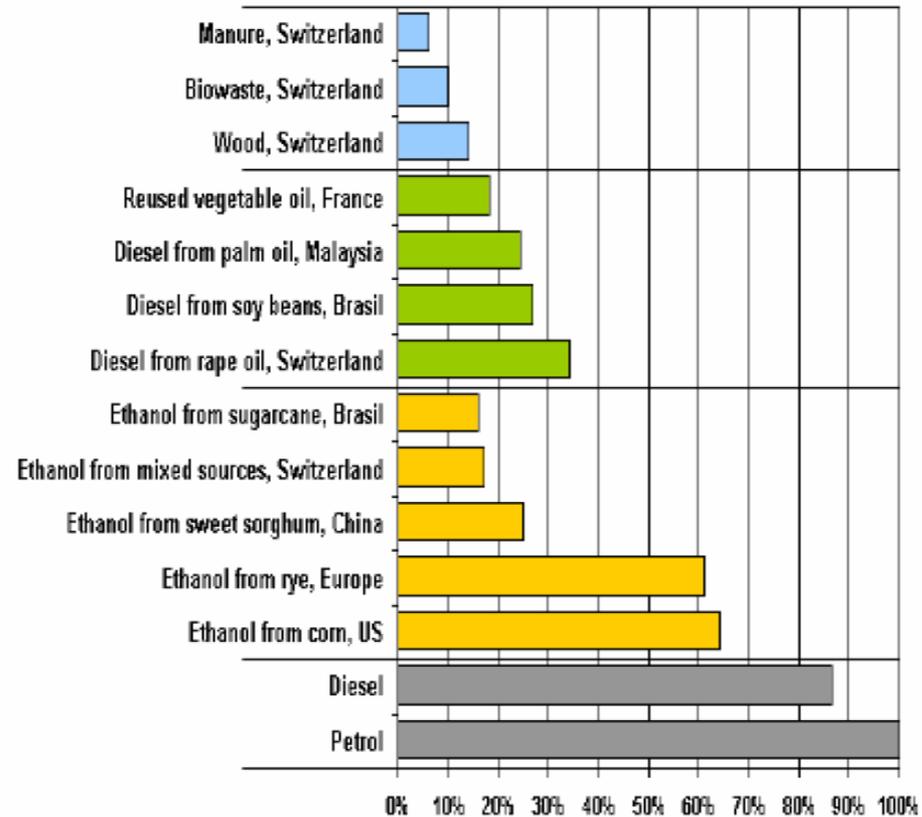
Peat Market = 80 million tons / year

AD in the Intermediate Future?

(3 – 10 years)



Fossil energy input of biofuels – Zah 2007



AD in the Future

Integration of Algae for biofuel production



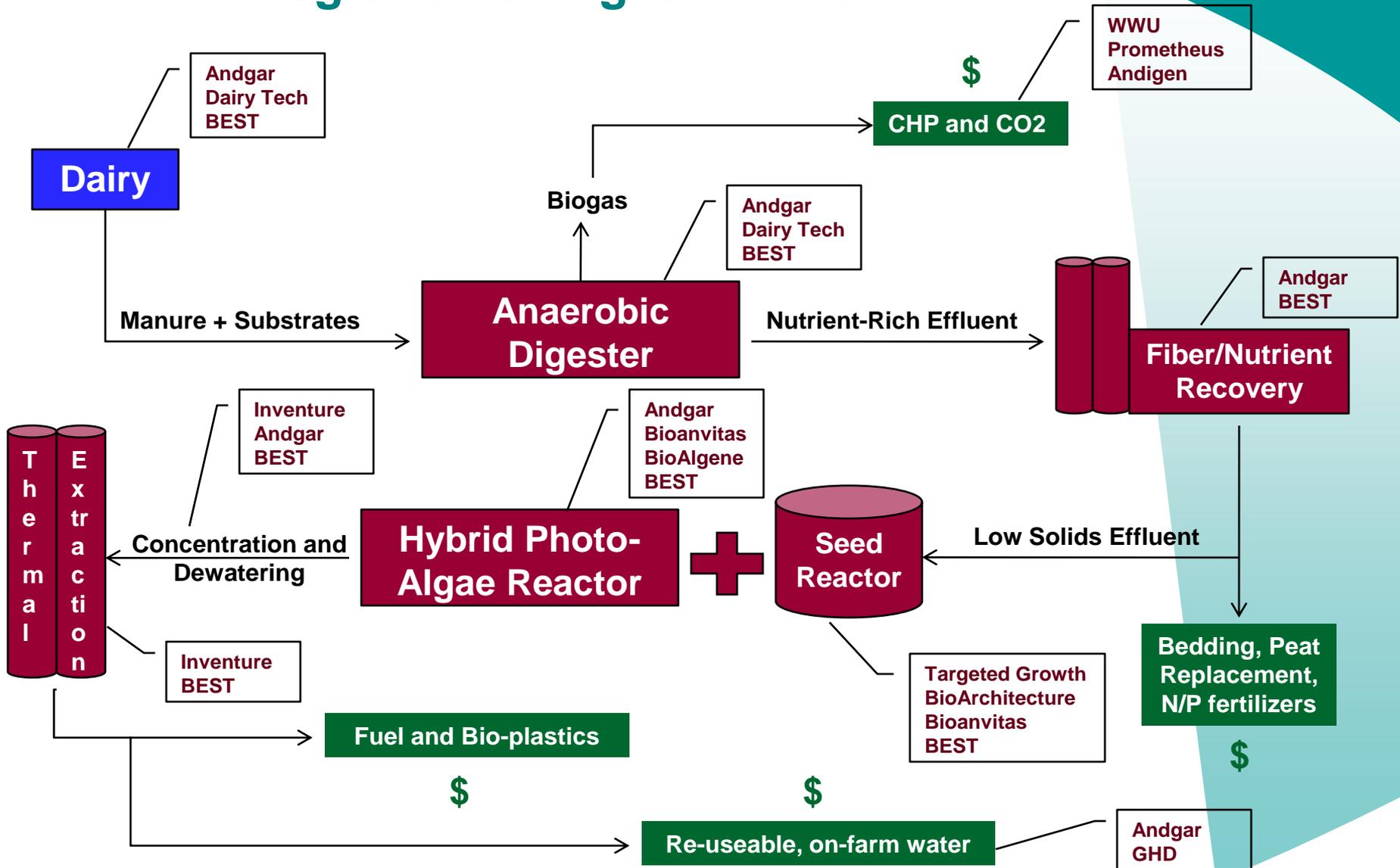
Spirulina Production in India

Large-scale, commercial growth of phototrophic microalgae is proven in regard to high value product development BUT needs R&D breakthroughs in *scaling, species selection, growth, concentration and extraction* in order to accomplish economical fuel production.

Washington State as Nexus of 2nd/3rd Generation Algae Biofuels Development

- Inventure Chemical, Bioalgene, BioArchitecture, Blue Marble, Targeted Growth, BEST, Bionavitas, etc.—core of algae-related start-ups now exist in State
- Boeing, PNNL, WSU and UW
- Columbia Basin Cascade Rain Shadow, Sunnyside Dairy Center
- Innovative, progressive municipal waste treatment—Tacoma, Seattle, King County

Integration of Algae with Farm AD





**CLIMATE
FRIENDLY FARMING™**